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High Resolution Stratigraphy and Evolution of Sperchios Delta Plain-Greece Based on Optical Dating of Quartz and Feldspar

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The establishment of the Holocene stratigraphic configuration of deltaic successions around the Mediterranean has been the study of several researchers over the last few decades (e.g., Bruno et al., 2015), with much of the associated research being focused on sedimentological and geochemical analyses (e.g., Pechlivanidou et al., 2014), tectonics and geodynamics (e.g., Lafuerza et al., 2005) as well as seismic profile analyses (e.g., Styllas, 2014).

Sperchios delta plain is located in central Greece and covers an area of 121.5 km^2. The hydrological regime in the area and the tectonic activity in the basin have forced the river's main channel to shift its course several times in the past, leading to the development of many deltaic prolongations and the creation of an extensive deltaic plain (Poulos et al., 1997). Earlier studies in Sperchios delta plain have primarily been focused on the reconstruction of the shoreline at the time of the ancient battle terrain of Thermopylae (Kraft et al., 1987; Vouvalidis et al., 2010a), while more recently the palaeogeography of the Late stages Holocene Sperchios delta plain has been described by Pechlivanidou et al. (2014) and Tsakalos et al. (2016), based on palaeontological, geochemical and sedimentological analyses on deltaic deposits.

However, numerical ages of the different deltaic sedimentary faces have been very limited, bringing uncertainties on the sequential history of the upper part of Sperchios delta plain. Previous chronological research in the delta (Pechlivanidou et al., 2014; Vouvalidis et al., 2010b) was based on archaeological and radiocarbon dates, with 14C ages bearing a number of limitations (e.g., sample contamination and uncertainties associated with the estimation of the C-14 to C-12 ratio). Furthermore, even though the luminescence dating techniques are now extensively applied to variety of sedimentary environments (e.g., aeolian, fluvial and marine), their application on fluvial and deltaic deposits still limited, since incomplete bleaching of sediment grains may be apparent. In such environments, sunlight exposure of sediments transported by fluvial processes may be very short-time and/or water turbulence may not allow direct sunlight exposure and thus full resetting of their luminescence signal (Dietlefsen, 1992; Rendell et al., 1994).

In this regard, an absolute dating study by Tsakalos et al., (2018) examined the applicability of the Optically Stimulated Luminescence (OSL) technique on sand sized (coarse) quartz from Sperchios delta deposits and provided a reliable chronological framework for the upper (~20 m) sedimentary deposits of Sperchios delta plain. This study also revealed that the distributions of the "equivalent dose" (D_E) values of the dated coarse grained quartz are over-dispersed, which may be considered as typical for fluvial sediments (e.g., Arnold et al., 2009). However, this problem of obtaining the best estimate of D_E and thus calculating a reliable age was overcome by the use of a number of statistical approaches.

Here we present a new-detailed Holocene chronological framework for the Sperchios delta along with sedimentation rates of its depositional sequences. Our approach is based on an enhanced chronological model which builds on the earlier set of luminescence ages on coarse quartz produced in the area by Tsakalos et al. (2018). The current study adopts the systematic employment of the luminescence dating techniques on fine (4-11 μm) quartz and coarse (80-125 μm) feldspar grains. The use of fine quartz will allow checking the hypothesis of a more effective resetting mechanism of the fine grained fraction (as opposed to coarser) during transportation and deposition. For age consistency check, samples dated here are exactly the same as the ones dated using the conventional Single Aliquot Regenerative (SAR)-OSL protocol in the study by Tsakalos et al., (2018). Samples were collected from five boreholes and are associated with different sedimentary facies (transgressive and regressive deposits that overlay late Pleistocene deposits) Fig. 1. To this end, the produced ages put additional strain on the applicability and reliability of the different luminescence techniques for dating deltaic deposits.

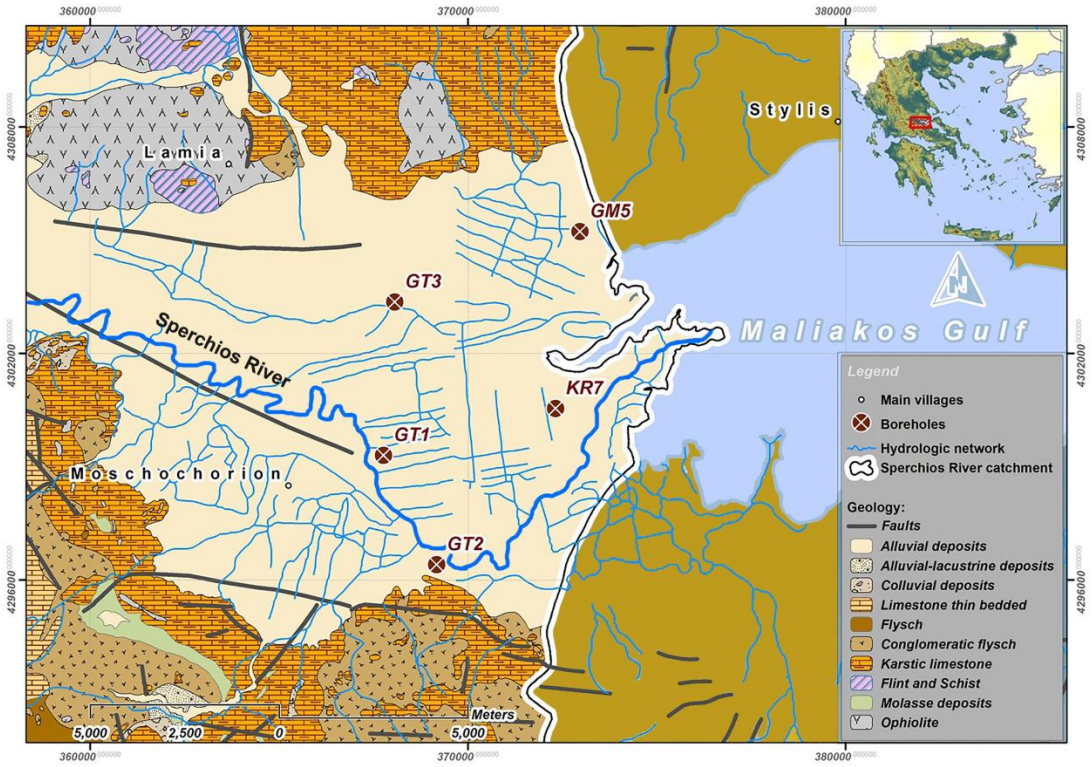

Fig. 1 Study area and sampling sites of the five cores (after Tsakalos et al., 2018).

Our luminescence dating results provided evidence of an Early to Late Holocene deposition for the upper 20 m of the delta and shorted in chronostratigraphic order. Further, the absolute ages derived by both fine quartz and coarse feldspar grains the are in agreement with independent previous choronological studies (radiocarbon dating) conducted in the area (Pechlivanidou et al., 2014) and in great consistency with the coarse quartz OSL ages by Tsakalos et al. (2018). The produced information adds to the widely accepted consensus regarding a consistent late Pleistocene to Holocene stratigraphic configuration of Mediterranean deltas while at the same time further contribute to the development of an evolutionary model of Mediterranean low-lying coastal areas subject to rising sea level rates.

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